DOCUMENT RESUME

ED 028 955 SE 006 734

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Wyndham Science.

Sidney Univ. (Australia).
Pub Date 68
Note-21p.
EDRS Price MF-$0.25 HC-$1.15
Descriptors-Biological Sciences, Chemistry, College Science, *Course Descriptions, *Curriculum Development, Evaluation, *Integrated Curriculum, *International Education, Physical Sciences, Physics, Program Descriptions, Science Education, *Secondary School Science, Textbooks
Identifiers-Australia, New South Wales, Wyndham Science

Described is the Wyndham science component of the program designed for the six years of secondary schooling for students in New South Wales, Australia. A subjective evaluation of the program and suggestions for improving course materials and teaching are given. There are six major sections in the report: (1) a general outline of the structure and purposes of the scheme, (2) the effect of the scheme on teachers and teaching, (3) a descriptive evaluation of the textbooks, (4) a discussion of the testing program, (5) a description of course aids, equipment, and laboratories, and (6) an evaluation of how the program dovetails into university courses in science. (GR)

ED028955

The University of Sydney

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WYNDHAM SCIENCE

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Introduction:

A great deal has been written on the Wyndham Scheme of education, now entering its eighth year in the schools of New South Wales. The six year science component of the scheme has probably received as much discussion as the rest of the entire scheme. Some of this discussion has been relatively informed, some slanted and a good deal of it simply incorrect. It is important that the science component—which directly or indirectly increasingly affects so many aspects of the national scene—should be clearly understood.

Wyndham science is not a unicellular creature, but a complex organism with many interwoven components. If any headway is to be made in emphasising both the good points and shortcomings, it is essential to try to distinguish these main components. Almost invariably in the past, due to one or more failings of one of the scheme's components it has been attacked and its withdrawal suggested: the syllabus is too long or complex—"throw out the scheme"; the examinations are too hard—"throw out the scheme"; there are too few adequately trained science teachers—"throw out the whole scheme". This is akin to a similar attitude in regard to people who are slightly injured and prescribing the equivalent cure: he has a sore finger—"cut off his head"; he has a broken leg—"cut off his head", and so forth. Rather an extreme cure to say the least! Let us examine the patient carefully and prescribe remedial action where necessary, but also when, on examining him we find he is relatively one of the healthiest patients ever examined—let us also tell him so!

For purposes of this article, Wyndham science will be broken down roughly into the following six components although at times it may be difficult to talk of one without the other:

1. The scheme itself.
2. The syllabi on the scheme and teachers and teaching.
3. The textbooks on the syllabi.
4. Course aids—the curriculum—equipment and laboratories.
5. The examinations.
6. University courses following on.

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1. THE SCHEME ITSELF

The general scheme increased the period of secondary schooling from five to six years and hence was expected to bring the students to a higher standard and greater maturity than the previous five year secondary school course.

For science, the scheme consists of a required four-year integrated course in which the subjects of physics, chemistry, biology, geology and astronomy are integrated—that is presented as a conceptual unity—and taught as such—at various prescribed levels according to the ability of the pupils concerned. This I shall term as the Junior Stage or as Stage 1. It is the normal terminal science course for the large majority of students: for those finishing school at this stage and for those students not proceeding with science based courses at the next stage of their studies. Stage 2 or Senior Science for the fifth and sixth years of secondary schooling consists of a co-ordinated course in which chemistry and physics form a compulsory core with side lobes consisting of various combinations of physics, chemistry, biology and geology. Stage 2 Science is also taught at various prescribed levels, the 2S, or short course, consisting of 6 periods of science per week; the 2F, or full course, 9 hours per week; and the 1F course, 11 hours per week. For students not proceeding on to science based courses at the tertiary level, a third level integrated course of science is also available. The courses thus not only cater for a wide range of intellectual competence but for a wide range of interests as well.

Now it is this scheme of the six-year science course—integrated in the first four years and co-ordinated in the last two—which has received world wide acclaim. For many years leading secondary school educators the world over had been working towards general acceptance of such a scheme, realizing that secondary school science courses short of this simply would not prepare students adequately to live in the world of tomorrow, where the boundaries of the individual sciences are becoming increasingly indistinct. It was such a scheme which was overwhelmingly and enthusiastically recommended at the recent international Bulgarian conference (Congress on the Integration of Science Teaching held by the Inter-Union Commission on Science Teaching of the International Council of Scientific Unions) on secondary school science teaching attended by the leading secondary school science educators from throughout the world. Any discussion in Australia berating its one true science scheme should be treated with more than a little suspicion. Furthermore, those States in Australia which have not already adopted such a scheme might be well to start doing so now—even if they do re-import it from overseas. Considering that

N.S.W. was the first in the world to implement the science scheme, any talk of rediscovery or of N.S.W. joining other States in its rediscovery sounds rather strange.

2. THE SYLLABUS ON THE SCHEME AND TEACHERS

A considerable amount of confusion has arisen in the past by talking of the science scheme and the syllabus on it as one and the same thing. Obviously a wide variety of syllabi can be written on the scheme—syllabi to meet the varying needs of individual nations, states and regions. The N.S.W. syllabi to be discussed briefly below are but one example of syllabi written to meet the particular needs of this State and it is these syllabi which have been discussed overseas as example of what *can* be done. They have not been adopted as they stand by anyone else for it would be strange indeed if the needs and emphasis given by various regions were to be the same. In fact ideally, uniform syllabi should be discouraged and such subjects as an Australian 'national' science syllabus hardly bear serious discussion.

The Junior Syllabus

The N.S.W. four-year Integrated Science Syllabus came into effect some seven years ago. Because of the undue haste with which the Government decided to implement the Wyndham Scheme, the syllabi for the Integrated Science Course—along with syllabi for all other subjects—had to be prepared in a period of time which was far too short, in fact scandalously short.

The N.S.W. Education Department's Secondary School Board appointed a School Certificate Science Syllabus Committee. This committee chose as its members, the leading secondary and tertiary science teachers of the community, with proper dominance given to practising secondary school science teachers. There is no reason to believe that the members of this Committee could have been bettered in N.S.W., or in fact had they been chosen from throughout Australia. They were as representative a group of dedicated, knowledgeable science educators as existed in this country. The work these teachers performed and the speed and success with which they performed it was short of miraculous. By January 1962, the first year syllabus was ready for teaching in the schools that year; by November 9, 1962, the remainder of the four year Integrated Science Syllabus was completed.

Teachers were invited to present the course so as to stress the unity of nature, the recognition and application of concepts common to several sciences and the interdependence of the sciences. Traditional deadwood was ruthlessly eliminated and students were to be taken to the 'frontiers of science' and shown the 'big ideas' which were energising modern science. In

particular, a number of major concepts were to form the all-pervading essence of the course to which teaching would be continuously related and so forth. It was different, it was new, it was modern.

The initial reaction to the first year syllabus was one of dumbfounded silence. The following year the silence was broken as teachers began appreciating the gigantic task before them, a task for which they and the schools were almost totally unprepared —a point to be discussed in some detail later. Criticism, which appeared to be that of the Integrated Syllabus, came thick and fast as former teachers of biology were asked to teach the physics, chemistry and geology sections of the new syllabus, and physics and chemistry teachers asked to teach the biology. But was this a criticism of the scheme and/or syllabus or was it a criticism of the fact that neither the schools nor the teachers had been adequately prepared—through no fault of their own—to teach the new and exciting science?

Looking back seven years, in retrospect it is evident that though the original four-year Integrated Science Syllabus was far from perfect in detail, it had made an exciting and revolutionary departure from the previous traditional syllabi. It has profoundly influenced thinking in regard to science teaching and science courses in general. Because the course began in 1962 immediately after the syllabus had been written, judgments in those days were naturally coloured. Problems associated with such external factors as facilities, equipment, teacher shortage, qualification and experience, tended to emphasise the deficiencies and obscure the virtues of the new scheme and syllabi.

In the light of five years' experience of both pupils and teachers, the four year Integrated Science Syllabus was carefully revised during 1967 to reduce its bulk, mainly at the Ordinary level, and to remove some anomalies which had become evident. It is really surprising to realize how little of the original syllabus had to be changed and speaks highly of it. It can now also be stated firmly that School Certificate Integrated Science has won almost unanimous (fortunately you will never get complete unanimity in matters of education!!) acceptance amongst N.S.W. pupils and teachers. Thus there can be no doubt that the integrated approach to Junior Science has been ineradicably established in N.S.W., that it has quickened the interest of both pupils and teachers who are gaining from it far greater satisfaction than was ever obtained from the previous traditional courses. Furthermore, an entirely new species of student is resulting from these courses. Other States may well take note.

All this is not to say that many nagging problems do not still remain in regard to Stage 1 or Junior Science, but largely these

are not shortcomings of the scheme or the syllabus. These problems centre mainly around aid, equipment and laboratory shortages, severe teacher shortages and inadequate teacher training and preparation—all matters of MONEY and not content or philosophy.

The Senior Syllabus for Stage 2

The syllabus to cover the co-ordinated two-year science course for the fifth and sixth years was prepared by a Science Syllabus Committee chosen by the N.S.W. Board of Senior School Studies. Membership of this committee was again chosen from among the leading science educators of the State with due emphasis now being given to representatives from tertiary institutions. This was in keeping with the more advanced level of the subject material to be covered and also with the fact that many of the students at the Senior level would be using their fifth and sixth years as a preparation for tertiary studies.

The Senior Syllabus, like the Junior one, was again prepared in great haste and under considerable pressure to have it out in time for the first Senior School year, namely 1966.

Teachers, already reeling under the impact of the Junior Science Syllabus and making valiant efforts to cope with it, were suddenly hit with a new and in many cases exciting and radical syllabus, but at a considerably higher level than that which faced them at the Junior Level. This resulted not only from the fact that the Senior Syllabus was carrying on from where the radically new Junior Syllabus left off, but also from the fact that the students were staying on in school for an additional year. With only several months to study the syllabus before beginning to teach it in February, 1966, the secondary science teaching community was shocked—shocked in a way it had never been shocked before! The problems of the Junior Course paled in significance in comparison with those of the new Senior Course. The Junior Science Course and its problems were now easy compared to that of the Senior one. Faced again with grave shortages of equipment, space, teachers' aids, an extra school year, and hence, almost invariably inadequate teacher numbers and preparation for the higher level, the science teaching community in many cases panicked. When panic rules supreme, logical argument and deduction become difficult or impossible. Almost everything in sight was attacked—the scheme, the syllabus, the books—everything except the thing which should have been attacked.

But here again, what about the Wyndham Scheme, or the co-ordinated Senior Syllabus? Were they so much at fault? The answer must be a resounding no. It is true that the original Senior Syllabus was like the original Junior one, far from perfect.

However, it was much superior to anything seen previously in the schools of N.S.W., the other States of Australia, or elsewhere in the world. Many curriculum reform groups throughout the world were deeply impressed by the ultra modern and forward looking aspects of the syllabus. It was exciting and contained numerous sections which they felt they would include in their own syllabi. Here now for the first time ever was a modern, integrated and co-ordinated science course spanning the whole six years of secondary schooling.

No one, however, disputed that the Senior Syllabus, like the Junior one, would after an initial run need to be considerably amended; yet certain sections of the educational community acted as if there was opposition to amendment of the Senior Syllabus. This building your own road block and then knocking it down did considerable harm. Not only did it tend to detract from the Wyndham Scheme and the merits of the many excellent aspects of the co-ordinated Senior Syllabus but, more importantly, it obscured the main difficulty: that of insufficient and adequately trained science teachers capable of coping with the new revolutionary and exciting syllabus.

Severe interim amendments have already been made to the Senior Syllabus and in the near future a series of further changes (carefully thought out it is hoped) will undoubtedly be made. There is however grave danger now, that because of teacher pressure on the syllabus rather than on teacher training and shortages, that the Senior Course will be destroyed—for it has already been seriously down-graded. A few more changes of the same nature will leave nothing but a facade of a Senior Course.

There will be much discussion of how and who will make the amendments: should there be more practising science teachers in the Senior Science Syllabus Committee; should there be a small full-time advisory group of top practising science teachers whose job would be to devote their sole efforts to the new syllabus (I believe this is a fine idea) and so forth? However the amendments are made, it should be made certain that the modern, forward looking nature of the new co-ordinated Senior Science Syllabus is retained and that N.S.W. ends up with even a better syllabus than it had before. Co-ordination and modernity must remain in Senior Science.

None of this, however, solves the really crucial issue at stake, namely that of inadequately prepared and insufficient numbers of science teachers? Old, shortened or amended Senior Science Syllabus—almost any Senior Syllabus carrying on beyond the present Junior one—the present science teachers will still be unable to cope with it for the simple reason that there is an insufficient number of them, and of the existing ones, most have

not been adequately trained or prepared. In the meantime, not only will the Senior Courses continue to suffer but the Junior ones as well. Because of the greater difficulty of the Senior Course (after all, the students stay on for an extra year!) the better science teachers are gradually being transferred from teaching the Junior Course to the Senior one—where in many instances they are still unable to cope. The result has been relatively poor teaching of both the Junior and Senior Courses, and because of this many students' keen interest in science is so dampened at the Junior level that they drop it in their fifth year. The serious consequences of this are still to be appreciated by our community.

What should have been done to prevent this sorry state of affairs, or more importantly, what can be done now to rectify it? Who was, and is, to blame for the mess? First let us be clear about one thing—the teachers are not to be blamed; they have, by and large, done a magnificent job in the difficult circumstances facing them. If any blame is to be attached to them, it is only for failing to keep the crucial issue of the teacher problem before the community. Instead they concerned themselves with distracting and far less important side issues.

The situation could have largely been prevented had the government of the day—*before implementing the Wyndham Scheme*—taken the necessary steps to ensure that a sufficient number of adequately trained science teachers would be available. This would have meant a crash programme of expanded teacher colleges and training centres—working if need be in the interim with the Universities throughout the State, providing night, weekend and summer courses. With a few minor exceptions, this crucial matter appears simply to have been ignored—"She'll be right mate"! If one reads Parliamentary and Press reports of the day, they are aglow with promises of, "being able to cope with the scheme", of "adequate finance being made available", and so forth. But few of the golden promises eventuated and the crucial problems were, in typical Aussie style, left to solve themselves or to fester or to simply go away. Unfortunately, basic educational problems do not have a habit of going away or solving themselves. They simply get worse and eventually the whole community pays a heavy price for its shortsightedness. Unfortunately, too, it is the youth of our State which suffers most.

Thus, the blame for the present situation lies fairly on the shoulders of the citizens and in turn on the Governments of this State. But what can be done now? Of course the hard-liners and many old-timers will simply say, "throw out the whole Wyndham Scheme and get back to the old-fashioned one, or

throw out Wyndham science". This would be akin to throwing out the baby with the bath water. One of the surprising points to be made again later, is that in spite of the serious difficulty being discussed, students coming out with Wyndham Scheme science are a better breed than any seen hithertofore. There can be no turning back now or lowering of aims and standards.

My proposals for remedial action are not new or cheap, and call for action on a variety of fronts. They are based on the premise that regardless of what farsighted and positive actions our State and Federal Governments may take immediately, the science teacher problem cannot be overcome satisfactorily overnight and in fact will not be solved satisfactorily until large numbers of the Wyndham Scheme students themselves become the teachers of it. I would suggest:

(a) An immediate expansion of science teacher in-service courses, with the Department of Education enlisting special aid from the Universities. Teachers should not be expected to take the courses in their own time without being recompensed for taking the courses. This could be done in a number of ways. Special summer courses should also be provided with proper recognition and recompense for those who take them. These actions would help upgrade and bring up to date, the present science teachers in the schools.

(b) As many high schools as possible should be selected or established, where the necessary high quality staff and equipment are available, for the provision of the Senior Science Courses in the manner in which they should be provided—and the courses should only be available at these schools. This is especially so for the Senior Short and Full Science Courses. As the number of adequately trained science teachers increases, the number of schools providing the courses would also be increased, with the aim in due course of again providing the complete course at all high schools. I realize this suggestion is nearly taboo in N.S.W. But what are the alternatives? It is no use saying science must be provided—and provided properly—at all high schools when in fact it cannot at present. Equally well, it would be the height of folly to keep cutting back the science courses so as to tailor them to the number and quality of teachers. We are in grave danger of quickly killing Senior Science.

An alternative which has great merit (the one I feel should be chosen) and which would be of immediate and long term benefit both to students and teachers is that of immediately televising and putting on videotape the complete Senior Science Course (it would also be a great move to do it for the four-year Junior Integrated Course). As will be mentioned later, this has already been done for a number of first year University of Sydney science

courses with considerable success. This would not only take the pressure off the science teacher and allow him much greater time for individual work with the class and laboratory experiments, but would also alleviate to a degree, the problem of the inadequately trained science teacher now so often being used for the teaching of the science courses. By using some of the best lecturers in the State, a uniformly high calibre science course would be provided to all students. Furthermore, the lecture demonstrations of important experiments would all be of top quality with adequate equipment being easily provided for the televising of the demonstrations. Many schools today simply still do not have adequate facilities either for lecture demonstrations or laboratory work.

(c) A concerted effort should be made to expand greatly the number of adequately trained science teachers being turned out in the State of New South Wales. This requires an attack on many fronts, from the administration of the present teachers' colleges right to increasing the numbers of teachers' colleges substantially. There are many further aspects here too, but this article is not the place to go into detail.

(d) A real effort should be made to not only hold the present science teachers but to attract new ones from elsewhere. It is all a question of money—not necessarily just increased salaries—but conditions of work, teaching aids, technicians and so forth.

It is evident that these proposals require substantial finance, however this simply must be found. The present ball-throwing between State and Commonwealth Governments in regard to finance for education does not seem to be producing much additional cash; certainly nothing approaching the realistic sums required. Is it not time that serious consideration be given to an educational tax throughout Australia? As one of the so-called advanced nations of the world, our expenditure on education on which our future depends is at a shameful low. I believe that on a per capita basis, we vie with Portugal. Any sane person will admit that such a state of affairs is scandalous.

3. THE SCIENCE FOUNDATION TEXTBOOKS ON THE SYLLABUS

The Junior books

The Junior Stage four year Integrated Science Syllabus was completed by November 9, 1962. But it is one thing to conceive a unique course aiming to integrate four major science fields and to plan a syllabus for it, and it is another thing to teach it to youth. That was where one of the early major practical difficulties of the Junior Integrated Science Course lay. Who could teach one course spanning four science fields? Who could teach it without

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a textbook, and, certainly not less problematic, how could students learn it without a textbook? And if not *one* teacher could at the time teach it without the guidance of a textbook, much less could *one* person write that textbook!

The practical implementation of the Wyndham science course thus hinged on finding a unifying force, a means to integrate experts in four sciences to perform the feat of creating from the essence of their special fields, one course capable of imparting basic general knowledge in all four fields.

The realisation that there must be fringe areas, side lines and overlaps in the preparation of such a course, and the fact that the course must not be an end in itself but must also provide a basis for further study, made it clear that not even four persons—one from each field—could write an adequate textbook. Within obvious limits, the larger and more representative the groups of writers would be, the more comprehensive would be the textbook. Realizing all the above, I decided to act and act quickly to help Wyndham science off the ground. Thus it was that I invited the Science Foundation to act as publisher of the now world famous Science for High School Students textbook series and Teachers' Manual, later to be followed by the Senior Science for High School Students Textbook series.

On August 9, 1962, the Science Foundation's School Certificate Integrated Science Textbook group was established with the full support of the then N.S.W. Government, the Department of Education, the University of Sydney and the Science Foundation. In excess of a thousand teachers in N.S.W. also gave a sigh of at least a little relief at the announcement of the plan.

The textbook group consisted of 32 members, and included as fine a representation of practising science teachers, school inspectors, teachers from teachers' colleges and university professors as could be found in the nation for the task at hand. Many other teachers not members of the group also contributed and gave invaluable aid. Looking back some six years, one still wonders how such a fine team of dedicated teachers was ever assembled. Certainly it had never been done before anywhere else in the world for an integrated science course—and it is unlikely to be repeated easily elsewhere in the future.

The first result of the group's efforts was the Pilot Edition of Science for High School Students. Some 3,000 copies of this book were provided free of charge to every practising science teacher in N.S.W. and 40 selected test classes in time for use during the 1963 school year. Using the results of questionnaires and thousands of other opinions from within Australia and overseas, the textbook group then prepared the first full scale

edition of Science for High School Students, and its companion Teachers' Manual. It was in the schools for the 1964 school year—and what a book it has been? In spite of violent argument over its weight and who printed it, its world wide reputation was quickly established and is still being echoed.

Then too as now, if one reads press reports, there was the dedicated small group of knockers who could not find a kind word to say for the books and could not possibly see why so many groups in Australia and throughout the world found them so praiseworthy. Everything from misprints to the most minor error was reported in detail via the N.S.W. press. It was an exciting time as the book went from print to print, being improved at each stage. The textbook group did not set itself up as an omnipotent group of writers, absolutely error-free; hard as they tried they still made errors and were, and still are, happy to correct them.

The textbooks were written as aids both for the students and teachers; the teachers' manual to help the teachers. They were written on the prescribed syllabus and gave an accurate modern and exciting interpretation of it. The Junior Syllabus has since been amended and thus the textbooks are in the course of amendment too. Students, teachers and parents alike will continue to have one of the most exciting and interesting science textbooks ever written at such a level and for such a course.

Since the original volume of Science for High School Students appeared, an Abridged version containing the material necessary for the modified and Ordinary syllabi (but not for Credit or Advanced) was brought out. This book appearing in two red volumes also quickly met with great success both in Australia and overseas.

The world rights for the textbook series outside of Australia were fast taken (after great overseas competition) by Pergamon Press Ltd. of London. A permanent group of writers in England have for the past two years been adapting the volumes for use in British schools at the C.S.E. level. The adaptation appearing in 13 volumes is scheduled to make its appearance in February of this year. The books are also being translated into French, German and Russian.

The Senior books

As mentioned previously, the co-ordinated Senior Science Syllabus was prepared under great pressure, to be ready for the 1966 school year. A modern, exciting and forward looking syllabus, many parts of which have been applauded overseas, was brought forth. But right from the start, it was evident that there were going to be difficulties teaching the new Senior Science Courses because of the teacher problems already discussed. If

many schools panicked with the syllabus and Foundation books available, it would have been an interesting spectacle to see what would have happened if they had had just the co-ordinated syllabus, without the Science Foundation Senior Science for High School Students Textbook series covering most of it? As in the case of the Junior Course—but even more so—the Senior Course without the Science Foundation Textbooks would have been chaotic.

Again, as in the case of the Junior Course, one of the most outstanding groups of teachers available in Australia, chosen from Universities and schools was brought together for the writing of the Senior Science for High School Students Textbook series which consist of four volumes: Part 1, Physics; Part 2, Chemistry; Part 3, Biology and a Teachers' Manual. Most of the chosen scientists were also members of the team concerned with the Foundation's Textbooks for the Junior Course. Thus the same remarks as made previously in regard to them again apply here. I know of no better team in this country or elsewhere. It should be clear that had I thought there were better people for the task at hand, I would have invited them to join us.

The Senior Syllabus was being assembled during 1965 and the writing of the Senior books on it took place concurrently. There was no opportunity for a pilot edition because pupils and teachers were in dire need of immediate help. As mentioned previously, the writers, like all mortals not having been bestowed with omnipotent error free powers, wrote the textbooks realising full well that in common with other textbooks, they would have minor errors and misprints too. But these could easily be corrected in succeeding reprints of the books, or during the course of a revision of the syllabus and books.

The textbooks were written to the co-ordinated syllabus and reflected in every way its modern forward looking content. Of course, those parts of the syllabus which included some dull sections led to correspondingly dull sections in the books. Even with the greatest of endeavour it is sometimes difficult to make important and necessary sections of science exciting. But surely the inclusion of a dull section in the syllabus does not warrant an attack on the text interpreting it? A lengthy discussion on the Senior Syllabus has already been given, and as pointed out it will be amended. Of course, the Senior Textbooks will be amended accordingly too. Included in the amendments will be the suggestions made by students and teachers throughout the world to help make the textbooks better still. The Foundation's Senior books do not cover the third level of the Senior Syllabus or the geology section of the remaining syllabus.

Reviews in leading educational and research journals (for instance Nature and Chemistry Education) throughout the world

have praised, and continue to praise the Senior Textbooks. Many of our textbook treatments of syllabus topics were new and had never been given before in such a fashion. They are continuing to be discussed most favourably in educational circles around the world—and when they are discussed it is not just N.S.W. which is mentioned—it is Australia. Pergamon Press again took the world copyrights for the books outside of Australia and again the texts are being translated into other languages. UNESCO has asked and obtained our permission to translate into all the various languages it concerns itself with, many of the exciting and new treatments which appear in the books. It is such judgments throughout the world which highlight the reputation of the books—judgments by world authorities and not by the ravings of a few jealous and prejudiced individuals nearby.

Like the Senior Syllabus, the Senior Textbooks took up where the Junior syllabus and books left off. Thus for the first time ever students were presented not only with an integrated and co-ordinated six year science syllabus but more importantly, with an integrated co-ordinated and unified textbook series (which also happen to be among the best and the cheapest of their kind anywhere!) spanning six years study of the major branches of science. There are simply no other books in existence which have been tailored completely to the N.S.W. six-year science course. Here again was a world first for Australia, and I say Australia advisedly.

An important point to be made here is that many of the Senior and Junior Textbook series writers were also members of the respective syllabus committees, thus helping to ensure that the books reflected the spirit of the syllabus. The same thing is now happening in various curriculum reforms taking place overseas. For instance, in England the Nuffield groups are not only concerned with the books and syllabi, but also the examinations on them. This ensures a uniform interpretation throughout the whole course from syllabus to final examination.

The Wyndham Science Scheme, its Junior and Senior Syllabi and associated textbooks have given N.S.W. and Australia a world lead in the sphere of secondary school science. We intend keeping things this way too. Many countries the world over are taking leaves out of the N.S.W. book and it would not be amiss for other States of Australia to do likewise. It is amusing to read of attempts by other States in Australia (which have in fact just been playing with the problem and using patchwork methods) to get N.S.W. to join them in their science reform efforts. Should it not be the other way around? New South Wales is so far ahead in its reform that anything other than this hardly merits discussion.

4. COURSE AIDS, THE CURRICULUM, EQUIPMENT AND LABORATORIES

The implementation of a major educational reform such as Wyndham science does not end with the preparation of a syllabus and textbooks. Unfortunately, as the community is now slowly beginning to realise, there is much more to it than that. In addition to the question of adequate teacher numbers, preparation and training already discussed, there are the problems of the provision of additional classrooms to cope with the extra year at school, the provision of additional science laboratories and new laboratory equipment to cover new experiments brought in by the new courses. Some substantial aid along these lines has already been provided by special Commonwealth science grants, but an examination of schools throughout N.S.W. will still show considerable shortages on most of these points.

Then, too, there is the provision of technical assistants for the science teachers in order that they be able to adequately cope with the new laboratory experiments and lecture demonstrations. The present grave teacher shortage is being further accentuated by utilizing the precious skill of the few teachers available, to carry out tasks which could more easily be carried out by technicians with far less training.

There are further needs in direct relation to the syllabi and textbooks covering them. Textbooks alone for students and teachers are not sufficient; teachers manuals to give hints and aid to teachers are also essential (these have been provided at both the Junior and Senior level by the Science Foundation) along with the development of visual aids such a film strips, movie films, experimental apparatus and new experiments to cover the courses. All of these are not one-shot affairs; the courses are living affairs and should be in the process of being developed and improved continuously. New ideas should be tried out; experiments designed to cover them, then introduced if they are good. However, all of this requires considerable effort—effort on a full-time basis by specialists. This total effort is what is sometimes called curriculum development, and it is at this level that Commonwealth guidance and aid for State co-operation should be operative.

The televising of the complete science course discussed earlier should also come under the present heading of a teachers' aid. It is obvious that all of the above again depends upon the community's willingness to provide the necessary funds. Only on their directions will the governments concerned do something about the provision of such funds.

5. THE EXAMINATIONS

Discussion of this topic is fraught with dangers and rather than stir up a hornet's nest on the general subject of methods of examination, I will but touch on it. Suffice it to point out that most educationists agree that present examination systems, whether for Wyndham science or any other subject, leave much to be desired the world over. The N.S.W. system is no exception, but it appears to be doing a first class job within the limits of present day examining methods.

Though there is general agreement that present day examining systems have their shortcomings, it is equally true that until someone is clever enough to come up with a better system (and one we can afford) of determining the students' grasp of the fields studied, the present system will remain.

The suggestion that examinations at the secondary level be abolished altogether is certainly not the answer for it will only postpone examinations to another body or to a later stage. The stage at which examinations are held and criteria established to help determine in which direction students should turn is largely a matter of finance. If the people and government are willing to allow every student to proceed to university, or equivalent, and through it without examination—and to meet the great costs involved in such a step—then undoubtedly many students could benefit. However, in present day Australian society, this is pie-in-the-sky. Most would like it and most would refuse to pay for it!

Due to the inherent shortcomings alluded to above, examiners should whenever in doubt give the benefit of the doubt to the student and remember that examination marks are not infallible guides. Such a broadminded outlook in regard to the Wyndham science examinations has largely dispelled the fears of students, teachers and parents alike, that the Wyndham science students were lambs to be taken to the slaughter.

6. UNIVERSITY COURSES FOLLOWING ON

The year 1968 was an interesting one for the Universities of N.S.W. and especially for Departments concerned with large first year student numbers. 1968 was the year of the first intake of the Wyndham Scheme students. For those university science departments who had taken Wyndham science seriously and determined to co-operate to help make it a success, it had meant a tremendous effort for the three years prior to 1968.

Let me discuss briefly the case I am best acquainted with, namely, that of the School of Physics within the University of Sydney. This is but an example, for I am well aware of other

science departments both within and out of the University of Sydney who took similar steps to those about to be described. I am also aware of university science departments who did not, who had prejudged the Wyndham science student even before the scheme began, who refused to change their syllabi for first year university courses, or if they were changed, the changes were minimal.

I leave it to the readers to determine for themselves those N.S.W. university science departments who have worked and co-operated wholeheartedly towards carrying through the results of Wyndham science to their ultimate conclusion and those departments which have not.

In the School of Physics preparations for the 1968 university first year began in 1965. A number of committees were established to determine what ramifications Wyndham science would have upon all existing first year physics courses and the courses of all subsequent years.

As the Junior and Senior Science Syllabi became available, study of them revealed that just a minor amendment to our university physics syllabi would not be sufficient, but that it would mean the scrapping of all our existing syllabi in all years—including the practical courses!! One can imagine the consternation and ripples set up within the School of Physics and the heated arguments which seemed to go on endlessly at the School's staff meetings and tea breaks during the ensuing two and a half years. Such changes meant an unbelievable amount of additional work for the School and expenditure of hundreds of thousands of dollars on new experiments and equipment. One can imagine why at least some university science departments might be reluctant to change.

The committees, not surprisingly, came to the conclusion that the Wyndham science students would be an entirely new breed of students. These students would have been taught in a different way, with different emphasis. Stress would have been laid on the teaching of scientific principles and not rote learning. Each student would have had four years of integrated science spanning the four major fields of science, followed by a further two years of co-ordinated science at varying levels but with physics and chemistry again playing dominant roles. The students would thus be more rounded and have at least some appreciation of the exciting problems now being tackled on the frontiers of science. We realized that even though now for the first time ever, most students will have had physics for six years before entering university science, many of these—those taking the lower level courses—would in fact have had less physics on entry than their predecessors who had just specialized in physics. However, it

had to be remembered that few of the predecessors ever had basic grounding in the other major sciences as well. It was all exciting, yet a daunting task of work lay ahead.

The physics committees included in their membership a majority of young, dynamic and forward looking staff members, members who could continue with the true spirit of Wyndham science. Young members clashed with older ones but all in an honest endeavour to provide the best first year physics courses possible. Time and again conflicting recommendations were brought to me, as Head of the School, for adjudication. Excitement ran high, no one quite knew why, but somehow there was the feeling that we in N.S.W. were entering a new era in university physics education. It was not just a question of higher standards or more mature students—it was something else—we were to deal with a new species of student.

In due course, the School of Physics staff meeting—which by the way have always included for the past 16 years all fourth-year and post-graduate students—agreed on the new first year physics syllabi and practical courses. There were, from 1968 onwards, to be only two first year physics courses: Physics IA for the very best or distinction students—for students intending to go on to specialize in physics or in other sciences requiring a detailed acquaintance with physics; and Physics IB for all other students requiring physics such as students in the life sciences, geologists, chemists, and so on. The two courses were tailored to interlock completely with the secondary school Senior Science Syllabi, thus students coming on to university would simply be carrying on from where they had left off in school.

First year student numbers in the School of Physics have varied from 1,400 to 2,200 during the past 15 years, but with the enforcement of university quotas, those numbers have stabilized around the 1,600 to 1,800 mark. Of these, it was expected that some 250 to 300 would enrol for Physics IA, the remainder for Physics IB.

The practical courses for both Physics IA and IB were completely re-designed and included many new and extremely interesting experiments, for instance—lasers are now being used right from the beginning. The complete attack and emphasis on practical work was changed, with more time being given for the performance of meaningful experiments, and the necessary senior staff supervision provided. We were really giving practical work a giant push forward. It is worth pointing out the considerable effort and finance required to bring into being such new practical courses for some 1,600 students. But it was done.

Physics 1B lectures are given to more than 1,300 students. Partly because of this, we have prerecorded at great expense and effort all the 78 lectures on television videotape. This had a number of advantages: all students get the same lecture; a great deal more time can be spent on each lecture (an average of 40 to 50 hours was spent on preparation for each lecture for television); many more experimental demonstrations can be included; and many demonstrations can be included which could not be shown in a normal lecture. Furthermore, the eight lecturers giving the T.V. course were all active members of their various research departments and are the best lecturers available in the School. Both mass and small group tutorials were given on the T.V. lectures and a book of detailed lecture notes provided to each student.

In the meantime, the second year physics committees had been hard at work and by December 1967 the new second year courses were agreed upon. Again there would be two second year courses—Physics IIA and Physics IIB, carrying on from where the two first year courses left off. And again the previous second year practical course was scrapped and a completely new course designed to replace it, with similar and increasing emphasis being given to the points mentioned in relation to the first year practical course. In excess of fifty thousand dollars was spent on new second year laboratory equipment. The second year courses using our new syllabi will be given for the first time commencing in March 1969.

During 1968 the third year physics committee was doing its job of preparing new syllabi and practical courses for the Physics IIIA and IIIB courses which will swing into action in 1970. During 1969, lecture notes on the new syllabi will be prepared and new experiments designed for the practical course. It will be a busy year to be followed by a further major effort to revamp our fourth or Honours year course.

This is not all, for we have already learned from the experience during 1968 with our new Physics I courses. Many people ask how did we find the new Wyndham students—better, as good as, or worse than their predecessors? What happened during the 1968 first year physics and science courses and what were the final results?

The general impression of the School of Physics staff was that the new students were probably a more mature, serious and stable group than their predecessors. As for better or worse—how does one compare an apple with a pear? Which is better? We could only say that the students were different from their predecessors—a new breed—and that we liked the breed. We also realized that in succeeding years the Wyndham students would improve as the system stabilized.

Our experiences during the first year with the new courses also were interesting. The Physics IA course went relatively smoothly but this was not surprising. The best students always seem to take changes, large and small, in their stride. Certain minor readjustments had to be made to the lecture course: more emphasis given to worked examples to make up for the decreased emphasis on problem solving in school and so forth. We were pleased with the Physics IA students and when the year ended the final results showed that the students had reached as high or even *higher relative level with the new increased standard course*, than their predecessors.

The Physics IB course with its 78 televised lectures required careful attention. It was something new for the students and something new for us in physics. We were prepared to be flexible in our attitude towards T.V. The first term of T.V. lectures brought forth a great cry from specific classes (from certain faculties), other classes from other faculties found the T.V. lectures hard, but were coping. We soon realized too that among the hardest lectures of the year were, in fact, being given in the first term, that more tutorials would be required, more worked examples given during the lectures and in the lecture notes. We had not taken sufficient cognizance of the fact that the Wyndham students, because of the pressure of time-tabling in the schools, were relatively less skilful in routine drill of solving numerical problems.

The first term results by and large reflected the reactions of the students; classes from some faculties did very well, others were managing, but classes from faculties with the weaker students needed help. Changes were introduced and the second and third terms went more smoothly. The students were learning and we were too—but faster! We went to great pains to gauge and assess student opinion; a questionnaire on the T.V. lectures was filled in by the students and the results studied by the first year physics committee.

The final Physics IB results contained no major surprises; it was just another average year with the students making an overall showing almost the same as that of previous years—but remembering, with a higher course standard.

An important point also came to light: whereas in previous years one would have students who would do well in one of the sciences and poorly in the others, the Wyndham students if they did well in one first year science course usually did well in the others too, and if poorly in one then also poorly in the others. Here we were seeing one of the really important benefits of Wyndham science—a well rounded student.

In view of our experience with the Physics IB television lectures during 1968, we have decided to re-do some 40 of the 78 lectures and lecture notes during the next two years. Thus our 1969 Physics IB course still will not be what we want it to be, but it will be better than the 1968 one. Each year the course will be improved. Undoubtedly changes will also have to be made to our new Physics IIA, IIB, IIIA and IIIB courses, after they have been tried, but this is not surprising and students will not be penalized. We are living in dynamic times—times of change—and are determined that everything possible is done to give the students a course which will not only excite them but give them pleasure too.

The new practical course offered in 1968 had its teething troubles too, but these were overcome and the year ended with an overwhelming feeling that the School was now providing a really first-class practical course.

Thus, students coming to the University of Sydney and majoring in Physics will not only had had a six year integrated-co-ordinated science course, but a ten year one! Where else in the world can this be equalled.

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